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METHOD AND APPARATUS FOR SHAPING GLASS SHEETS

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ABSTRACT OF THE DISCLOSURE

Glass sheets are shaped between press shaping molds having foraminous shaping surfaces. Heated gas and cooled gas are applied through the foramina of the shaping surfaces to separate the sheet from a foraminous surface in contact therewith and to cool the glass sheet respectivity. Reciprocating members engage the edges of the sheet to reciprocate the sheet in a generally horizontal direction until the glass sheet is no longer in a deformable state.

The present invention relates to bending glass sheets, and particularly relates to an improvement in shaping glass sheets by a press bending operation.

In a typical press bending operation, a series of glass sheets are conveyed through a furnace at a rate of speed that is correlated with the amount of heat supplied in the furnace to raise the temperature of each sheet of glass to its deformation temperature. When the leading sheet of glass in this series attains the desired temperature, it leaves the furnace and enters a shaping station. There, the heat-softened glass is press bent to a desired curvature between complemental shaping surfaces formed on the inner faces of a pair of contoured shaping molds. The glass sheets are then chilled as rapidly as possible if it is desired to temper the bent sheets after they are shaped.

In recent years, curved glass sheets have found increasing use as face plates for television tubes and as windows for automotive vehicles. The demand for these products has necessitated the development of mass production techniques to produce large quantities of curved glass sheets with a minimum of manual labor. The present invention provides a commercially practical mass production operation for producing curved glass sheets having very close dimensional tolerances throughout their entire extent, acceptable optical properties and uniform curvature from sheet to sheet.

Apparatus used to perform the above method usually comprises a pair of contoured shaping molds having foraminous shaping surfaces conforming to the shape desired for the opposite major surfaces of the bent glass sheet. According to the present invention, as least one of the molds comprises a chamber having a foraminous contoured wall conforming to the shape desired for a major surface of the glass sheet after bending. In order to avoid establishing a pattern of iridescence in the glass resulting from its non-uniform chilling immediately after its shaping, the present invention suggests reciprocating the glass sheet relative to the mold foramina during its quenching immediately following the press bending operation.

Apparatus for performing the present invention comprises a frame bridging a shaping mold and having glass edge engaging fingers extending through notches in the mold to beyond the mold. The fingers are spaced from one another a distance slightly greater than the corresponding dimension of the glass sheet.

Means is provided for reciprocating the frame and its glass engaging fingers at a frequency and displacement that is correlated with the arrangement of the apertures

in the shaping mold so that the glass movement is sufficient in both amplitude and frequency to avoid establishing the iridescent patterns resulting from chilling the glass through spaced apertures without providing relative movement. Control means is also provided to control the program of reciprocating the frame and the glass engaging fingers with the application of cold fluid against the major surfaces of the press bent glass sheet so that both operations take place simultaneously.

According to a particular embodiment of the present invention, the mold opposite the first mold comprises a second chamber having a foraminous contoured wall conforming to the shape desired for the opposite major surface of the glass sheet after bending. Both mold chambers have operatively connected thereto fluid supply means for introducing relatively cold fluid to each chamber for exhaust through its foraminous wall. The program control means operates for both molds so that the introduction of cold fluid takes place in unison into the two chambers as well as simultaneously with the reciprocation of the glass engaging fingers.

One of the molds has an outer wall of concave configuration. The other mold has an outer wall contoured to a convex configuration. It is usually desirable to apply fluid through only one of said walls immediately after bending the glass sheet to help disengage the sheet from the molds before applying the quenching fluid against both surfaces of the bent glass sheet. The present invention optionally includes means to control the selective application of fluid to one side only of the bent glass to help disengage it from the mold.

Means for providing relative movement of the foraminous contoured walls between a closed position and a retracted position is provided in an illustrative embodiment of the present invention. In addition, when desired, means responsive to the relative movement of the contoured walls toward a retracted position initiates the introduction of the fluid through the mold having a convex outer wall to help separate the bent glass from the convex wall. Immediately thereafter, relatively cold fluid is rapidly introduced into both mold chambers to chill both bent glass surfaces.

Relative movement between a glass sheet and opposing molds having glass quenching apertures in planes parallel to the major glass surfaces lessens iridescent patterns resulting from non-uniform cooling of the glass sheet. The prior art moved the molds to perform such relative movement. Since molds are usually very heavy, powerful motors and accessory motive equipment are used to reciprocate the apertured molds. Furthermore, motive equipment reciprocating the molds at a rapid enough frequency to avoid an iridescent pattern establishes vibration that is very uncomfortable for personnel tending the equipment.

The reciprocatory motion imparting equipment required for such heavy equipment requires a large initial capital investment. Such massive equipment is likely to break down frequently. Much production time is lost repairing the expensive equipment. In addition, an inventory of relatively expensive parts must be kept.

The present invention suggests moving the glass sheet rather than the molds in a two-and-fro motion after press bending. The motion imparting equipment needed to move the light, bent glass sheet relative to the mold apertures is very light, thus enabling it to respond rapidly to actuation and deactivation and to reciprocate at a sufficient frequency and amplitude to avoid establishing the iridescent pattern.

According to an illustrative embodiment, the motion imparting means comprises glass edge engaging fingers that contact alternate opposite glass edges to displace the glass sheet across the space between the retracted molds. Since the glass floats, it is free to move in an